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NATIONAL DAM SAFETY PROGRAM. PINE LAKE DAM (MO 30447), MISSISSI--ETC(U)
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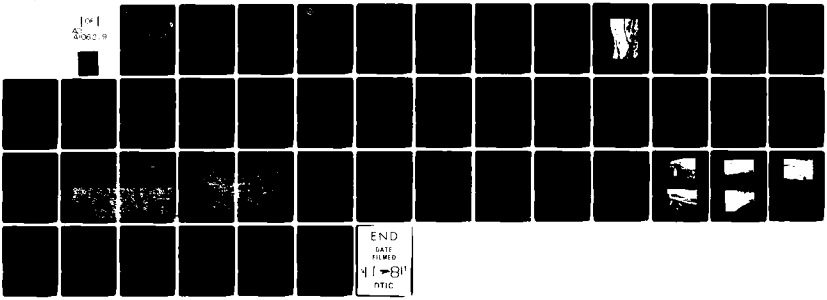

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MISSISSIPPI - KASKASKIA - ST. LOUIS BASIN

PINE LAKE DAM
JEFFERSON COUNTY, MISSOURI
MO 30447

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

"Original contains color plates: All DTIC reproductions will be in black and white"

DACW43-78-C-0143

PREPARED BY: U. S. ARMY ENGINEER DISTRICT, ST. LOUIS

FOR: STATE OF MISSOURI

DECEMBER 1978

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO. AD-A106	3. RECIPIENT'S CATALOG NUMBER 149
4. TITLE (and Subtitle) Phase I Dam Inspection Report National Dam Safety Program Pine Lake Dam (MO 30447) Jefferson County, Missouri		5. TYPE OF REPORT & PERIOD COVERED (9) Final ~~Rep~~
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Horner & Shifrin, Inc.		8. CONTRACT OR GRANT NUMBER(s) (15) DACW43-78-C-0143
9. PERFORMING ORGANIZATION NAME AND ADDRESS U.S. Army Engineer District, St. Louis Dam Inventory and Inspection Section, LMSED-PD 210 Tucker Blvd., North, St. Louis, Mo. 63101		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS U.S. Army Engineer District, St. Louis Dam Inventory and Inspection Section, LMSED-PD 210 Tucker Blvd., North, St. Louis, Mo. 63101		12. REPORT DATE (11) Dec~~ember 19~~78
		13. NUMBER OF PAGES Approximately 40
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) (10) Albert B./Becker, Jr		15. SECURITY CLASS. (of this report) UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for release; distribution unlimited. (12) 4

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

(6) National Dam Safety Program. Pine Lake Dam (MO 30447), Mississippi - Kaskaskia - St. Louis Basin, Jefferson County, Missouri. Phase I Inspection Report.

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Dam Safety, Lake, Dam Inspection, Private Dams

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.

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DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 NORTH 12TH STREET
ST. LOUIS, MISSOURI 63101

IN REPLY REFER TO

SUBJECT: Pine Lake Dam Phase I Inspection Report

This report presents the results of a field inspection and an evaluation of the Pine Lake Dam.

It was prepared under the National Program of Inspection of Non-Federal Dams.

This dam has been classified as unsafe, non-emergency by the St. Louis District as a result of the application of the following criteria:

1) Spillway will not pass 50 percent of the Probable Maximum Flood.
2) Overtopping could result in dam failure.
3) Dam failure significantly increases the hazard to loss of life downstream.

SUBMITTED BY: SIGNED — Chief, Engineering Division — 16 MAR 1979 Date

APPROVED BY: Signed — Colonel, CE, District Engineer — 20 MAR 1979 Date

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PINE LAKE DAM
JEFFERSON COUNTY, MISSOURI

MISSOURI INVENTORY NO. 30447

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

PREPARED BY:

HORNER & SHIFRIN, INC.
5200 OAKLAND AVENUE
ST. LOUIS, MISSOURI 63110

FOR:

U.S. ARMY ENGINEER DISTRICT, ST. LOUIS
CORPS OF ENGINEERS

DECEMBER 1978

HS-7848-10

PHASE I REPORT

NATIONAL DAM SAFETY PROGRAM

Name of Dam:	Pine Lake Dam
State Located:	Missouri
County Located:	Jefferson
Stream:	Tributary Rock Creek
Date of Inspection:	31 October 1978

The Pine Lake Dam was visually inspected by engineering personnel of the office of Horner & Shifrin, Inc., Consulting Engineers, St. Louis, Missouri. The purpose of the inspection was to assess the general condition of the dam with respect to safety and, based upon this inspection and available data, determine if the dam poses a hazard to human life or property.

The following summarizes the findings of the inspection and the results of certain hydrologic/hydraulic investigations performed under the direction of the inspection team. The following deficiencies were noticed during the visual inspection and are considered to have an adverse effect on the overall safety and future operation of the dam and spillway.

1. The upstream slope of the dam is irregular (maximum slope ratio is approximately 1v on 1.3h) beginning at a level about 12 feet below the top of the dam. Excessive irregularities of the face of the dam are indications of instability and/or erosion, both of which are considered detrimental to the safety of the dam.

2. A substantial cover of small trees and brush that may conceal animal burrows exists on the upstream and downstream slopes of the dam. The tree roots and animal burrows can provide a pathway for lake seepage that may develop into a piping condition.

3. The upstream slope has a grass cover to protect it from erosion by wave action. Grass cover is not considered adequate to prevent

erosion by wave action for a fluctuating lake level. Loss of material can result in instability and settlement of the dam crest.

4. A dense growth of brush and small trees obstructs the spillway crest and outlet channel. Obstructions within the spillway will restrict flow thus reducing the capacity of the section and/or result in flooding of the area adjacent to the spillway.

5. A shallow excavation for a lagoon exists adjacent to the downstream toe of slope. The possibility exists that this excavation is detrimental to the stability of the embankment.

The conditions described above are not considered to be serious at this time to warrant immediate remedial measures.

Based on the criteria set forth in the recommended guidelines (see text), and since numerous homes lie within the first one-half mile of the estimated flood zone, the recommended spillway design flood for this dam, which is classified as small in size and of high hazard potential, is considered to be Probable Maximum Flood (PMF). PMF is the flood that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. Results of a hydrologic/hydraulic analysis indicated that the existing spillway is inadequate to pass lake outflow resulting from a storm of PMF magnitude or the lake outflow resulting from the 1 percent chance (100-year frequency) flood without overtopping the dam. The existing spillway is capable of passing lake outflow corresponding to about 3 percent of the PMF. The length of the downstream damage zone, should failure of the dam occur, is estimated to be two miles. Within the first one-half mile downstream of the dam there are six to seven houses and associated buildings, two improved road crossings, and one unimproved road crossing.

A review of available data did not disclose that seepage and stability analyses of the dam were performed. This is considered a deficiency and should be rectified.

It is recommended that the Owner take the necessary action in the near future to correct or control the deficiencies and safety defects reported herein. As an alternative to correcting or controlling the noted deficiencies and safety defects, the Owner may remove the dam in the near future.

Albert B. Becker, Jr.

Albert B. Becker, Jr.
P.E. Missouri E-9168

OVERVIEW OF LAKE AND DAM

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
PINE LAKE DAM - ID NO. 30447

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APPENDIX

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
PINE LAKE DAM - ID NO. 30447

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

a. Authority. National Dam Inspection Act, Public Law 92-367, dated 8 August 1972.

b. Purpose of Inspection. The purpose of this visual inspection was to make an assessment of the general conditions of the dam with respect to safety and, based upon available data and visual inspection, determine if the dam and spillway pose a hazard to human life or property.

c. Evaluation Criteria. This evaluation was performed in accordance with the "Phase I" investigation procedures as prescribed in "Recommended Guidelines for Safety Inspection of Dams," Appendix D to "Report of the Chief of Engineers on the National Program of Dams," dated May 1975.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances. The Pine Lake Dam is an earthfill type embankment rising approximately 33 feet above the original stream bed. Lake level is governed by a shallow excavated earth type spillway section located adjacent to the left (looking downstream) abutment. The spillway outlet channel joins the original main tributary approximately 300 feet below the dam. At normal pool the lake surface occupies approximately 6 acres. There are no drawdown facilities for dewatering the lake. A shallow pond, approximately one-half acre in area that at one time was a sewage treatment lagoon, lies immediately below the dam. At the time of the inspection, the pond was empty.

b. Location. The dam and lake are located on an unnamed tributary of Rock Creek, approximately 3.5 miles west of Seckman, Missouri, in Jefferson County. The dam is located in Section 6, Township 42 North, Range 5 East, approximately 1.0 mile north of the intersection of Ridge Road and State Highway 21, as shown on the Regional Vicinity Map, Plate 1.

c. Size Classification. The size classification, based on the height of the dam and storage capacity, is categorized as small. (Per Table 1, Recommended Guidelines for Safety Inspection of Dams.)

d. Hazard Classification. According to the St. Louis District, Corps of Engineers, the Pine Lake Dam has a high hazard potential, meaning that the dam is located where failure may cause loss of life, serious damage to homes, agricultural, industrial and commercial facilities, important public utilities, main highways, or railroads. The estimated flood damage zone, should failure of the dam occur, as determined by the St. Louis District, extends two miles downstream of the dam. Within the first one-half mile downstream of the dam there are six to seven houses and associated buildings, two improved road crossings, and one unimproved road crossing.

e. Ownership. The property on which the dam lies is owned by the Missouri State Highway Commission, Highway Department Building, Jefferson City, Missouri, 65101.

f. Purpose of Dam. The dam was originally constructed for the purpose of recreation by the former owner. However, in 1976 the property, including the dam, lake and other improvements, was vacated, having been acquired by the Missouri State Highway Commission for right-of-way for relocation of Highway 21.

g. Design and Construction History. In 1959, the dam was constructed to a height of about 15 feet by the Oscar Johner Excavating Company of Barnhart, Missouri, for the former owners of the property, Mr. and Mrs. Everett L. Foster. In 1961, the dam was raised to its present height (approximately 33 feet) by the Lingle Excavating Company, formerly of Florissant, Missouri. The present

status and location of the Lingle Excavating Company are unknown. In about 1968, an attempt was made to prevent excessive loss of water from the lake by grouting the permeable layers beneath the dam with hot asphalt. This grouting program was not considered successful since, during grouting, over 12,000 gallons of asphalt were pumped into one hole alone and the possibility remained that the lake would continue to lose water. In about 1972, with approximately 15 feet of water in the lake, a major leak suddenly developed in the lake bottom and in two days' time the lake lost all of its water. In order to seal the leak, a clay blanket was installed over the entire bottom of the lake. Since installation of the clay blanket, the former owner reported that no additional work has been done on the dam and that the water in the lake has not reached a depth greater than 15 feet. At the time of the inspection the lake contained water to a depth of approximately 10 feet.

According to the former owner, no design data or analyses were employed to determine the structural or hydraulic capability of the dam.

In 1976 the property, including the dam and lake, were sold by Mr. and Mrs. Foster to the Missouri State Highway Commission for relocation of Highway 21. A plan showing the proposed highway in the area including the dam is shown on Plate 2. According to a representative of the Missouri State Highway Department, these improvements are scheduled for construction sometime in 1982 or 1983.

h. Normal Operational Procedure. Normally the lake level would be regulated by overflow of an uncontrolled, excavated earth, spillway. However, it is not known if the leak in the lake has been effectively sealed and that the lake level will be maintained at the spillway crest elevation. According to the former owner and prior to 1976, the lake level had not reached the spillway crest.

1.3 PERTINENT DATA

a. Drainage Area. The area tributary to the lake is virtually undeveloped and, in a natural state, covered with native grasses and timber. There are a few homes in the subdivision development at the uppermost end of the watershed. The watershed area above the dam amounts to approximately 154 acres. The watershed area is outlined on Plate 1.

b. Discharge at Damsite.

(1) Estimated known maximum flood at damsite ... Unknown[1]

(2) Spillway capacity ... 20 cfs

c. Elevation (ft. above MSL). At a point 10 feet south of a 9-inch diameter wood post located near the east end of the dam, the top of the dam was assumed to be elevation 754, the basis for this assumption being the contours, at 2-foot intervals, shown on the plan for the relocation of Highway 21 by the Missouri State Highway Department. The following elevations were measured in the field using the above benchmark.

(1) Top of dam ... 751.9 (min.)

(2) Normal pool (spillway crest) ... 751.3

(3) Streambed at centerline of dam ... 719±

(4) Maximum tailwater ... Unknown

(5) Pool at date of inspection ... 729.8

d. Reservoir.

(1) Length of normal pool (elevation 751.3) ... 1,200 ft.

(2) Length of maximum pool (elevation 751.9) ... 1,300 ft.

e. Storage.

(1) Normal pool ... 77 ac.ft.

(2) Top of dam (incremental) ... 10 ac.ft.

(1) According to the former owner, the lake level had not exceeded the spillway crest prior to 1976.

f. Reservoir Surface.

(1) Top of dam ... 7 acres

(2) Normal pool ... 6 acres

g. Dam.

(1) Type ... Earthfill, homogeneous (per former owner)

(2) Length ... 425 ft.

(3) Height ... 33 ft.

(4) Top width ... 10 ft.

(5) Side slopes

  (a) Upstream ... 1v on 2.6h (irregular)[1]

  (b) Downstream ... 1v on 3h

(6) Cutoff ... Core trench (per former owner)

(7) Core ... None

(8) Slope protection

  (a) Upstream ... Grass

  (b) Downstream ... Grass

h. Spillway ... Excavated earth V-section at left abutment.

i. Outlet for Lake Drawdown ... None provided.

(1) Slope 1v on 1.3h begins approximately 12 feet below top of dam.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

No engineering data relating to the design of the dam are known to exist.

2.2 CONSTRUCTION

No records relating to the construction of the dam are known to exist.

2.3 OPERATION

The present lake level is governed by the amount of seepage occurring. When and if corrected, the lake level would be governed by an uncontrolled, excavated earth spillway. According to the former owner of the dam, the maximum depth of water in the lake was about 15 feet (elevation 736±) prior to 1976.

2.4 EVALUATION

a. Availability. Engineering data for assessing the design of the earthfill dam and spillway were unavailable.

b. Adequacy. No data available.

Since it appears that the dam will be demolished or the lake filled for a roadway embankment in the very near future, and since it also appears that the lake leaks quite badly when the lake level rises, it is questionable at this time whether further considerations should be given to improving the dam for safety reasons. However, taking the viewpoint that the roadway may not be constructed, the following statement is included.

Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General. A visual inspection of the dam and spillway was made by Horner & Shifrin engineering personnel (R. E. Sauthoff, Civil Engineer and Hydrologist; A. B. Becker, Jr., Civil and Soils Engineer) on 31 October 1978. Also inspected at that time was the area downstream of the dam, including the various road crossings between the dam and the junction of the tributary with Rock Creek, a distance of about 2 miles. Photographs of the dam taken at the time of the inspection are presented on pages A-1 through A-3 of the Appendix.

b. Dam. The visible portions of the upstream and downstream faces of the dam (see Photos 1 and 2) appeared to be in sound condition although numerous small trees and brush exist on both slopes. Examination of the downstream toe of slope and the junction of the embankment at the abutments did not reveal any signs of seepage. No surface cracking of the exposed ground surface along the dam crest or elsewhere was noticed. The slope of the upstream face of the dam was noticeably irregular beginning at a point about 12 feet below the top of the dam. It could not be determined if the irregularity of the dam face was due to sloughing or to erosion at what may have once been the waterline. There is no riprap slope protection on the upstream face of the dam. A trail, believed to be created by motorcycles, extends from the valley floor to the dam crest on the downstream face of the dam. According to survey data, the top of the dam was found to be approximately 1.0 foot lower at a point approximately 130 feet from the spillway than the top of the dam at a point adjacent to the spillway. A profile of the top of the dam extending through the spillway crest is shown on Plate 3.

There exists a remnant of a shallow (3 feet) pond (see Photo 5), approximately one-half acre in area, adjacent to the downstream toe of slope near the center of the dam. At the time of the inspection the pond was empty, the bottom dry and overgrown with weeds. According to the former owner, this pond was at one time a sewage treatment lagoon that served the owner's home. The

lagoon influent line that reportedly entered the lagoon at the east side was not noticed during the inspection.

c. Spillway. The crest and outlet channel of the excavated earth spillway, located at the left abutment, appeared to be in sound physical condition although in disrepair and overgrown with small trees and dense brush (see Photos 3 and 4). Erosion, presumably due to storm drainage runoff, has created a small gully, about 10 inches deep in places, along the alignment of the spillway channel. The spillway channel joins the original main tributary approximately 300 feet below the dam. A profile of the spillway channel is shown on Plate 3.

d. Downstream Channel. The downstream channel is unimproved except in a section about 4,000 feet below the dam, where a commercial bank-type fishing enterprise has widened and deepened the stream for a distance of approximately 1,000 feet. Water is contained within this area by a low dam that the Owners have constructed across the downstream end of the improvement. The tributary joins Rock Creek at a point about 2 miles below the dam.

e. Reservoir. The area around the lake is essentially in a natural state. The upstream end of the lake appeared to be in a marshy condition and the lake water contained considerable quantities of algae. The amount of sediment present in the lake could not be readily determined.

3.2 EVALUATION

The deficiencies observed during this inspection and noted in paragraphs 3.1b and 3.1c are not considered of major consequence to warrant immediate remedial action.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

The spillway is uncontrolled. The water surface level is governed by rainfall runoff, evaporation, seepage, and the capacity of the uncontrolled spillway.

4.2 MAINTENANCE OF DAM AND SPILLWAY

Based on the substantial cover of small trees and brush on the upstream and downstream slopes of the dam and spillway, it is apparent that these areas have not been maintained for some time. According to the former owner, the property was vacated sometime in 1976.

4.3 MAINTENANCE OF OUTLET OPERATING FACILITIES

No outlet operating facilities exist at this dam.

4.4 DESCRIPTION OF ANY WARNING SYSTEMS IN EFFECT

The inspection did not reveal the existence of a dam warning system.

4.5 EVALUATION

A poorly maintained dam is considered detrimental to the safety of the dam. Further, since acquisition of the property in 1976 by the Missouri State Highway Commission, the dam and spillway have been unattended and allowed to fall into a state of disrepair. Without maintenance on a regular basis and periodic inspection, the safety of the dam is jeopardized.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. Design Data. Design data are not available.

b. Experience Data. The drainage area and lake surface area were developed from the USGS Maxville and House Springs, Missouri, Quadrangle Maps. The spillway and dam layout were developed from surveys made during the inspection.

c. Visual Observations.

(1) The excavated earth spillway section and the outlet channel are in poor condition. Some minor erosion of the spillway crest and outlet channel has occurred and small trees along with dense brush are present in the channel.

(2) Drawdown facilities are not provided to dewater the lake.

(3) The spillway and outlet channel are located in the left abutment. Spillway releases within the limited capacity of the spillway will not endanger the integrity of the dam.

(4) A dry shallow pond, reported to be a sewage lagoon, lies immediately below the dam.

d. Overtopping Potential. The spillway section is inadequate to pass the probable maximum flood, the 1/2 probable maximum flood, or the 1 percent chance (100-year frequency) flood without overtopping the dam. The results of a dam overtopping analysis are as follows:

Ratio of PMF	Q - Peak Outflow (cfs)	Max. Lake Water Surface Elev.	Max. Depth of Flow Over Dam (Elev. 751.9)	Duration of Overtopping of Dam (Hours)
0.03	20	745.9	0	0
0.50	1,410	748.0	2.1	16.9
1.0	2,960	748.7	2.8	17.6
100-Year Flood	830	747.6	1.7	9.8

The flow safely passing the spillway just prior to overtopping amounts to about 20 cfs, which is equivalent to about 3 percent of the probable maximum flood inflow, and is less than the 1 percent chance (100-year frequency) flood.

Procedures and data for determining the probable maximum flood, the 100-year frequency flood, and the discharge rating curve for flow over the spillway and the dam crest are presented on Pages B-1 and B-2 of the Appendix. A listing of the HEC-1 (Dam Safety Version) input data is shown on Pages B-3 through B-5 of the Appendix. A copy of the computer output tables entitled "Summary of Dam Safety Analysis" is presented on Page B-6 of the Appendix.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations. Visual observations which adversely affect the structural stability of the dam are discussed in Section 3, paragraph 3.1b.

b. Design and Construction Data. No design or construction data relating to the structural stability of the dam are known to exist.

c. Operating Records. No appurtenant structures or facilities requiring operation exist at this dam. According to the former owner, no records were kept of lake level, spillway discharge, dam settlement, or seepage.

d. Post Construction Changes. According to the former owner, with the exception of grouting the dam foundation in 1968, no post construction changes were made which would affect the structural stability of the dam.

e. Seismic Stability. Since the dam is located within a Zone II seismic probability area, an earthquake of the magnitude predicted is not expected to produce a hazardous condition to the dam, provided that static stability conditions are satisfactory and conventional safety margins exist.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. <u>Safety</u>. Several items were noticed during the visual inspection that adversely affect the safety of the dam. These items, which exist on both the upstream and downstream slopes of the dam, are trees and dense brush. A similar condition exists at the spillway. Evidence of sloughing and/or erosion was also observed along the upstream face of the dam.

A hydraulic analysis indicates that the excavated earth spillway section is capable of passing lake outflow of about 20 cfs without the level of the lake exceeding the low point of the dam. A hydrologic analysis of the lake watershed area, as discussed in Section 5, indicated that for storm runoff of probable maximum flood magnitude the lake outflow would be on the order of 2,960 cfs, and for the 100-year frequency flood the lake outflow would be about 830 cfs.

No stability and seepage analyses of the dam or hydraulic analyses of the spillway are known to exist.

b. <u>Adequacy of Information</u>. Due to the lack of engineering and construction data, the assessments reported herein were based on external conditions as determined during the visual inspection. The assessment of the hydrology of the watershed and capacity of the spillway were based on a hydrologic/hydraulic study as indicated in Section 5. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

c. <u>Urgency</u>. The items concerning the safety of the dam noted in paragraph 7.1a and the remedial measures recommended in paragraph 7.2 should be accomplished in the near future.

d. Necessity for Phase II. Based on the results of the Phase I inspection, a Phase II investigation is not recommended.

e. Seismic Stability. Since the dam is located within a Zone II seismic probability area, an earthquake of the magnitude predicted is not expected to produce a hazardous condition to the dam, provided that static stability conditions are satisfactory and conventional safety margins exist.

7.2 REMEDIAL MEASURES

a. Recommendations. Present planning by the Owner (the Missouri State Highway Commission) calls for removal of the dam sometime about 1982 or 1983, when construction of new Highway 21 through this area is undertaken. However, in accordance with the criteria set forth in the guidelines, the dam (in its present condition) was determined to pose a hazard to human life and property, and unless certain improvements to the dam and spillway are made, a potentially dangerous and unsafe situation exists. It is recognized that the Owner has the option of removing the dam in order to eliminate the hazardous conditions described herein; however, if so elected, removal of the dam should be accomplished without delay. If removal of the dam is not accomplished as soon as feasible, then the following actions are recommended:

(1) Based upon the criteria set forth in the recommended guidelines, alterations to the design of the dam should be made in order to to pass lake outflow resulting from a storm of probable maximum flood magnitude.

(2) Obtain the necessary soil data and perform stability and seepage analyses in order to determine the structural stability of the dam for all operational conditions. Seepage and stability analyses should be performed by a professional engineer experienced in the design and construction of dams.

(3) Investigations should be performed to determine the cause of excessive loss of water from the lake and if a condition related to the loss of water exists that could jeopardize the safety of the dam, such as cavernous bedrock underlying the dam that could collapse, resulting in failure of the dam. Recommendations concerning methods by which such loss of water could be prevented or controlled if considered critical to the safety of the dam should be a part of the investigating procedures.

b. Operations and Maintenance (O & M) Procedures. The following O & M procedures are recommended:

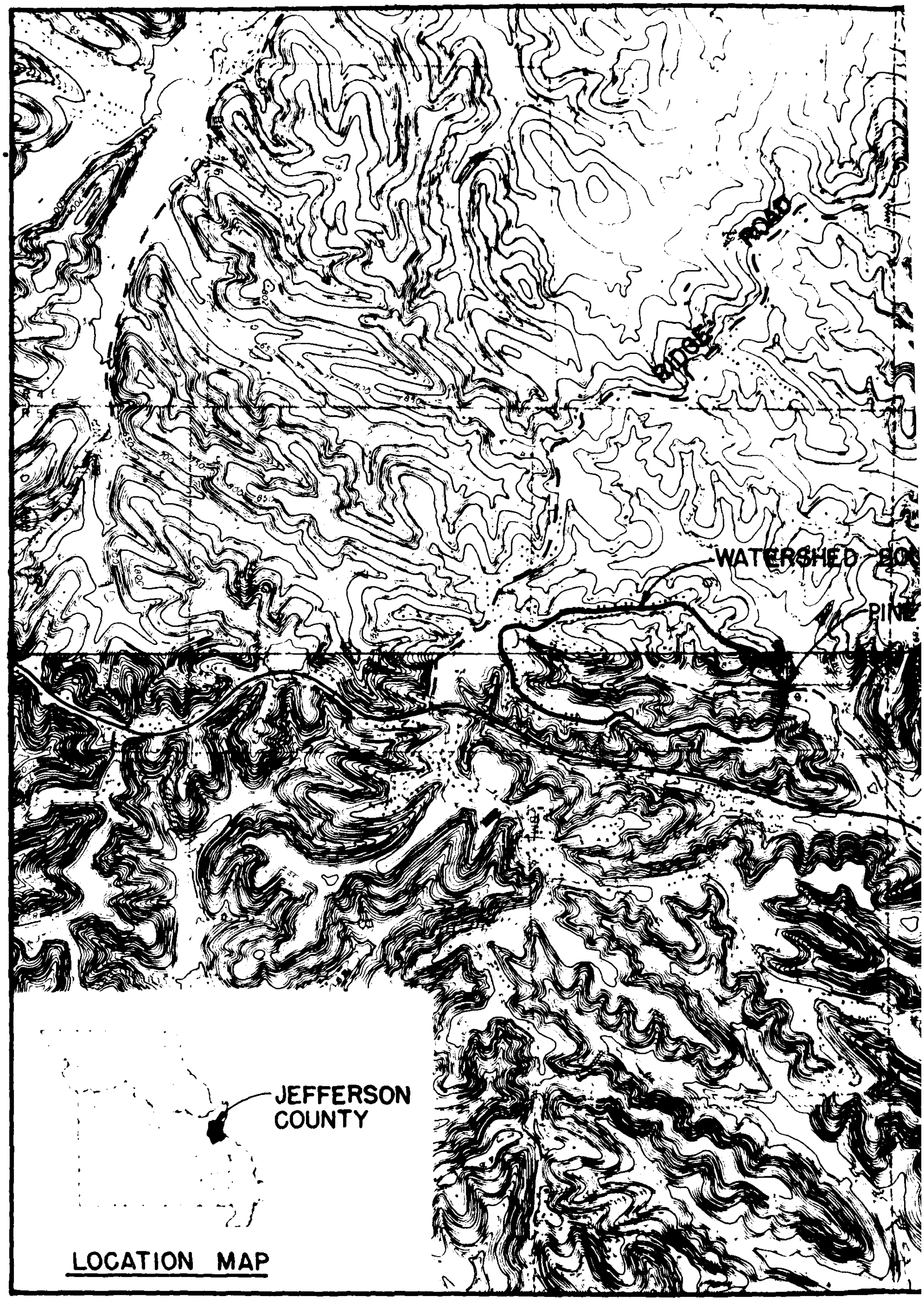
(1) Remove the trees and brush from the upstream and downstream faces of the dam. Tree roots provide a passageway for seepage than can lead to a piping condition and potential failure. The turf cover should be restored if destroyed or missing. Maintain the turf cover on the slope at a height that will not hinder inspection or harbor burrowing animals.

(2) Remove the trees and brush from the spillway crest and channel in order to allow flow to reach the downstream channel unrestricted. Obstructions within the spillway will restrict flow and reduce the discharge capacity of the section and/or result in flooding of the area adjacent to the spillway.

(3) Restore the upstream face of the dam and provide some form of protection for the dam face at and above the normal waterline in order to prevent erosion by wave action.

(4) Provide maintenance of all areas of the dam and spillway on a regularly scheduled basis in order to insure features of being in satisfactory operational condition.

(5) A detailed inspection of the dam should be instituted on a regular basis by an engineer experienced in the design and construction of dams. It is also recommended, for future reference, that records be kept of all inspections made and remedial measures taken.


RIDGE ROAD
WATERSHED BO
PINE
JEFFERSON
COUNTY
LOCATION MAP

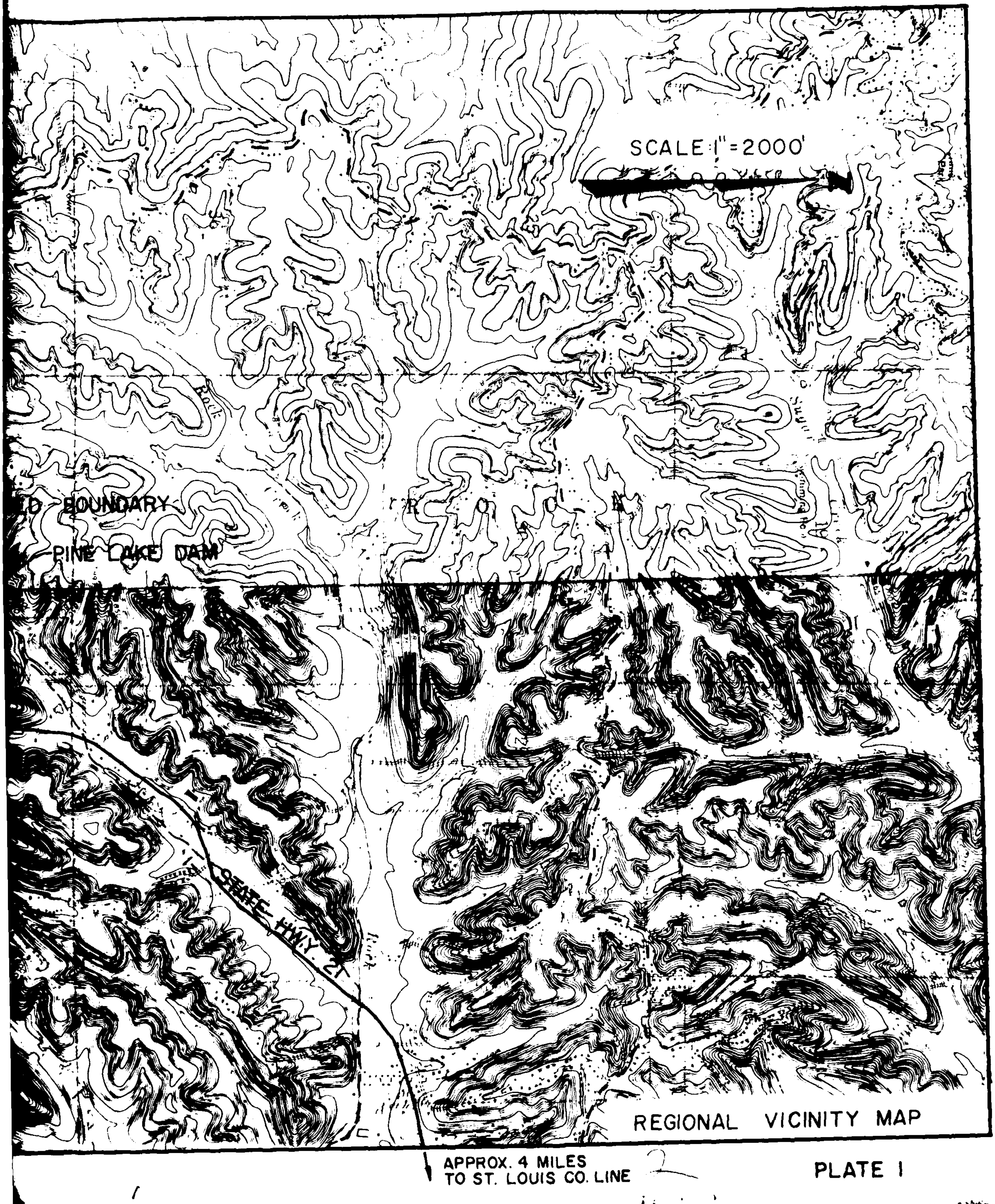
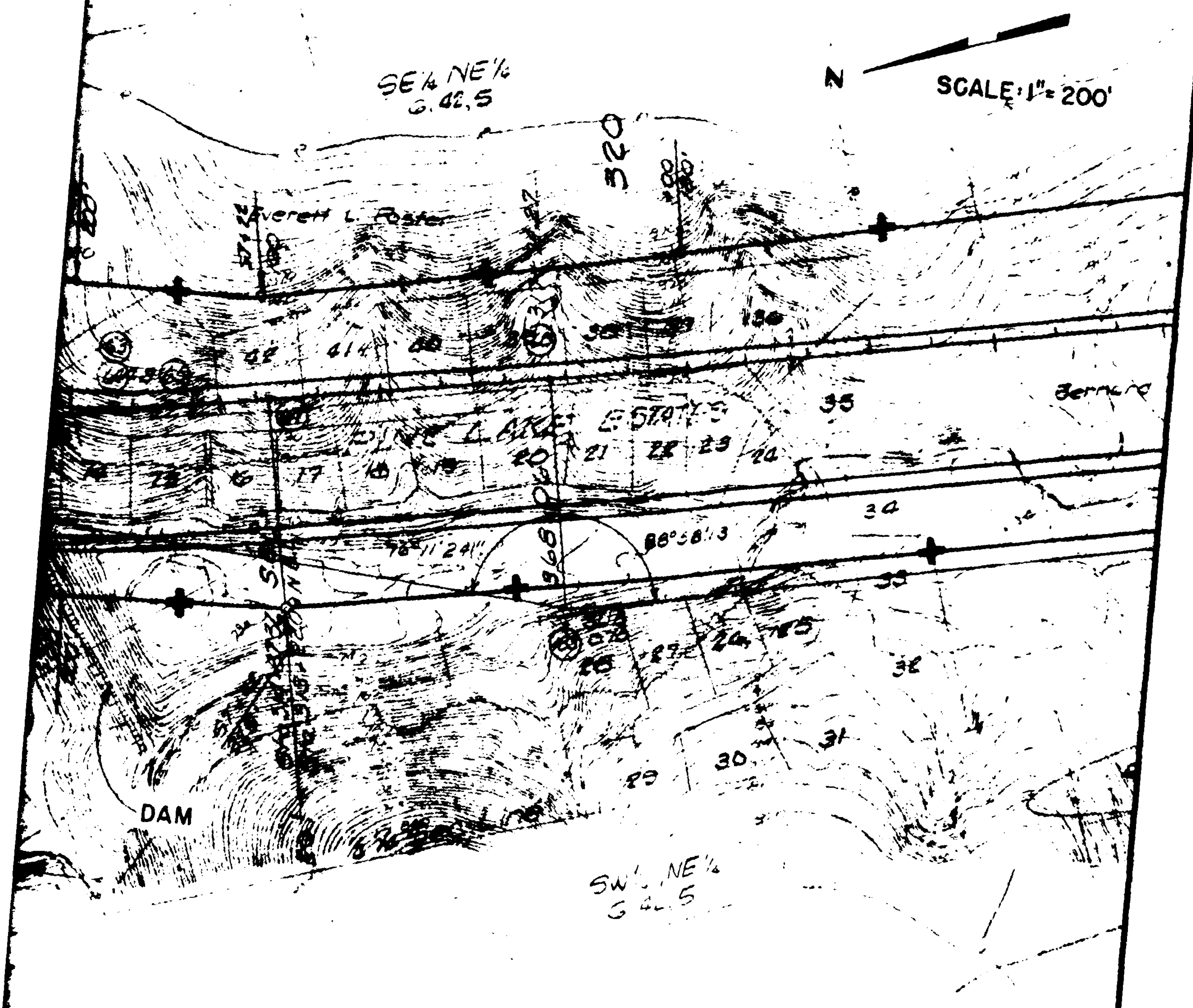

SCALE 1" = 2000'
D BOUNDARY
PINE LAKE DAM
STATE HWY. 21
REGIONAL VICINITY MAP
APPROX. 4 MILES
TO ST. LOUIS CO. LINE

PLATE 1


Warren J. Becker
NW¼ NW¼
S,42;5
300
Sec 6
Sec 6
31
Gravel
Everett L Ford
Henry Wright
NE¼ NE¼
6 42;5

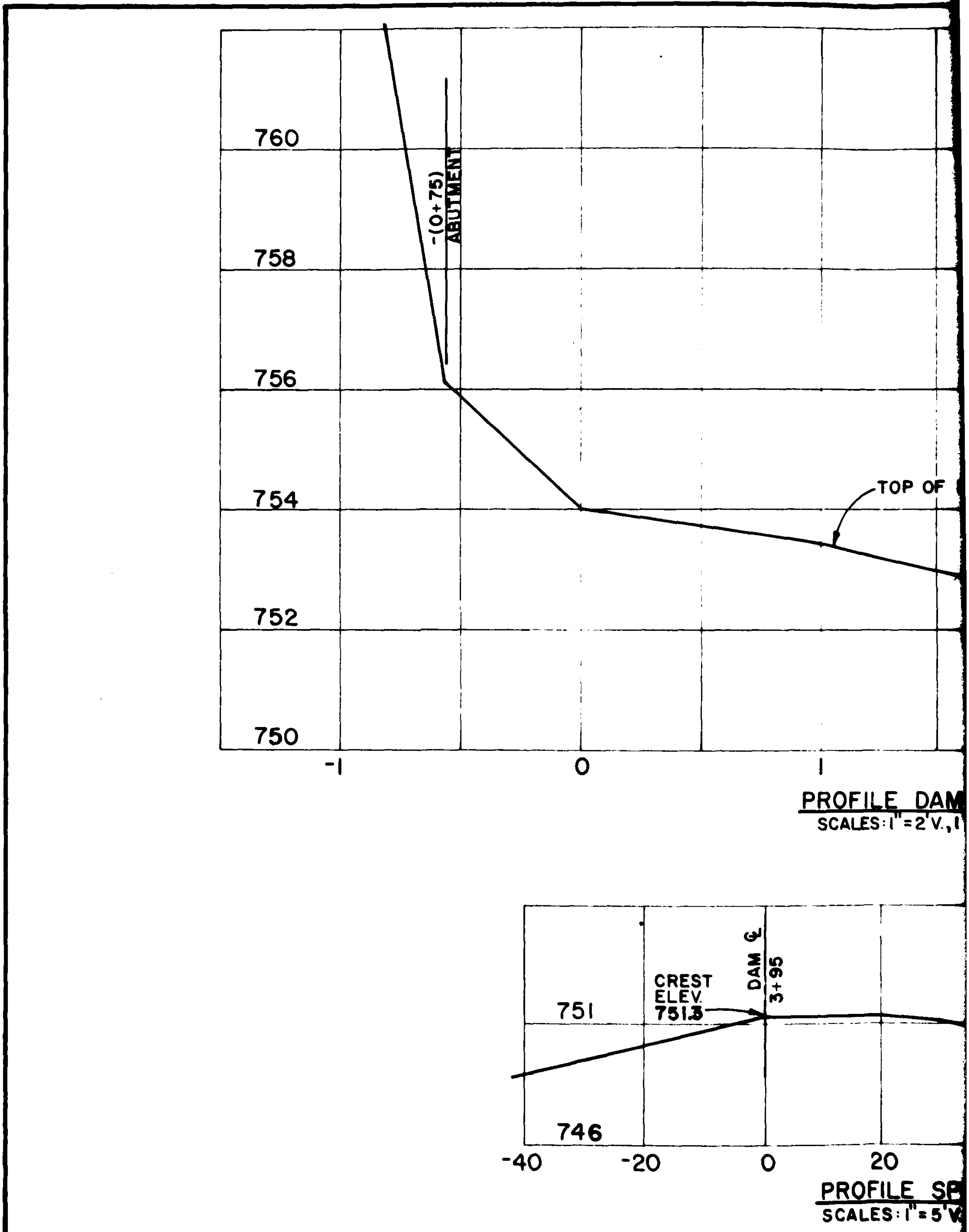


PROPOSED IMPROVEMENT
STATE HIGHWAY 21
(By Missouri State Highway Dept.)

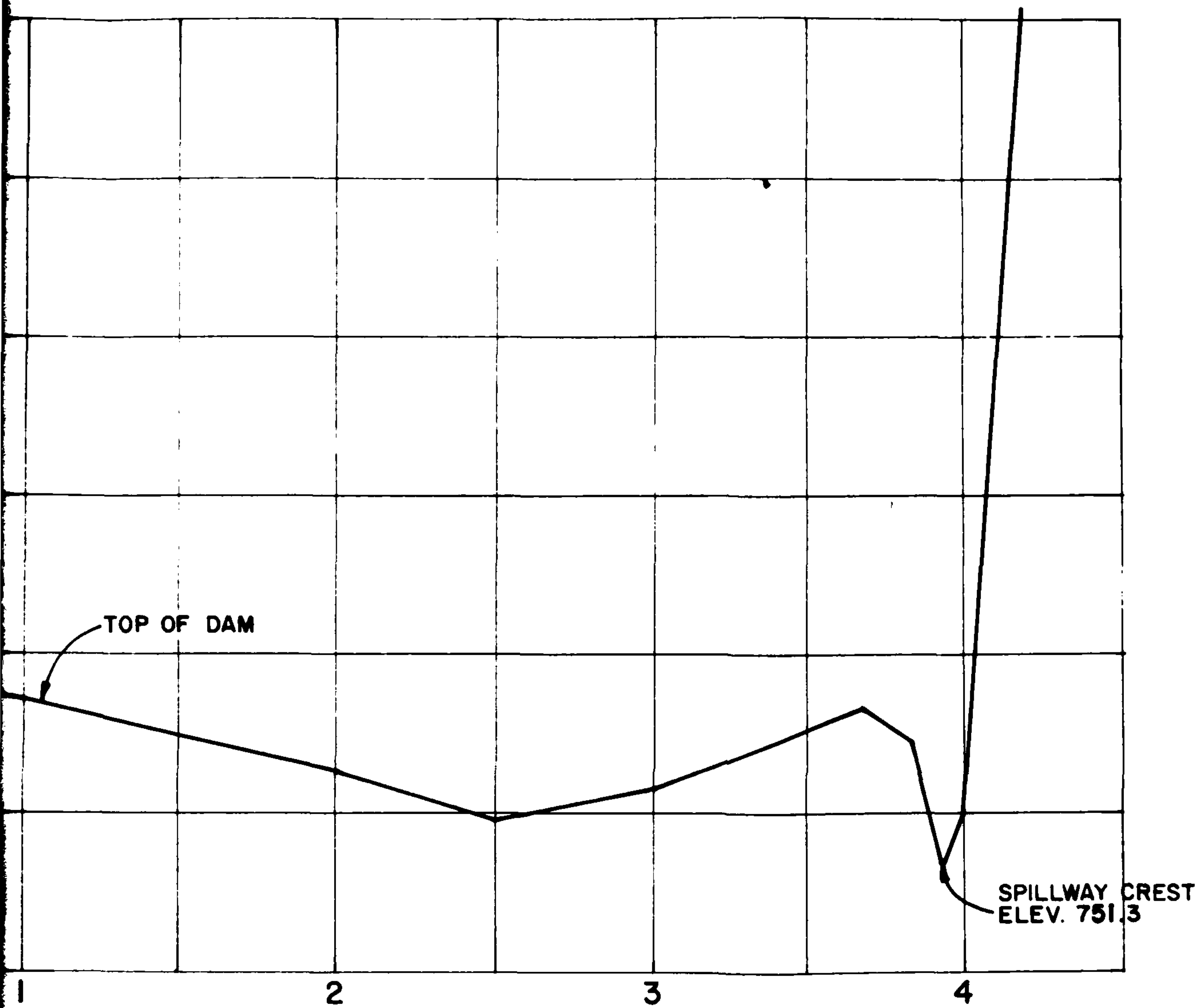
1

2

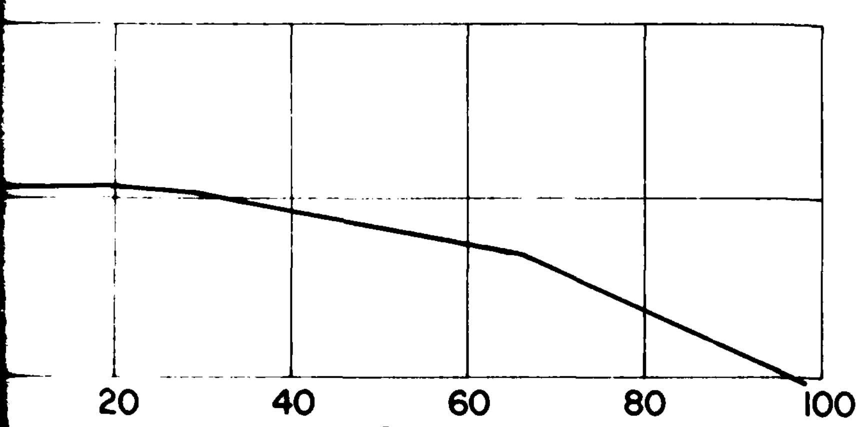
PLATE 2



760
758
756
754
752
750
-1
0
1
-(0+75)
ABUTMENT
TOP OF
PROFILE DAM
SCALES: 1"=2'V., 1'
751
746
-40
-20
0
20
CREST
ELEV.
751.3
DAM ℄
3+95
PROFILE SP
SCALES: 1"=5'V.



PROFILE DAM CREST
SCALES: 1" = 2' V., 1" = 50' H.



PROFILE SPILLWAY ℄
SCALES: 1" = 5' V., 1" = 20' H.

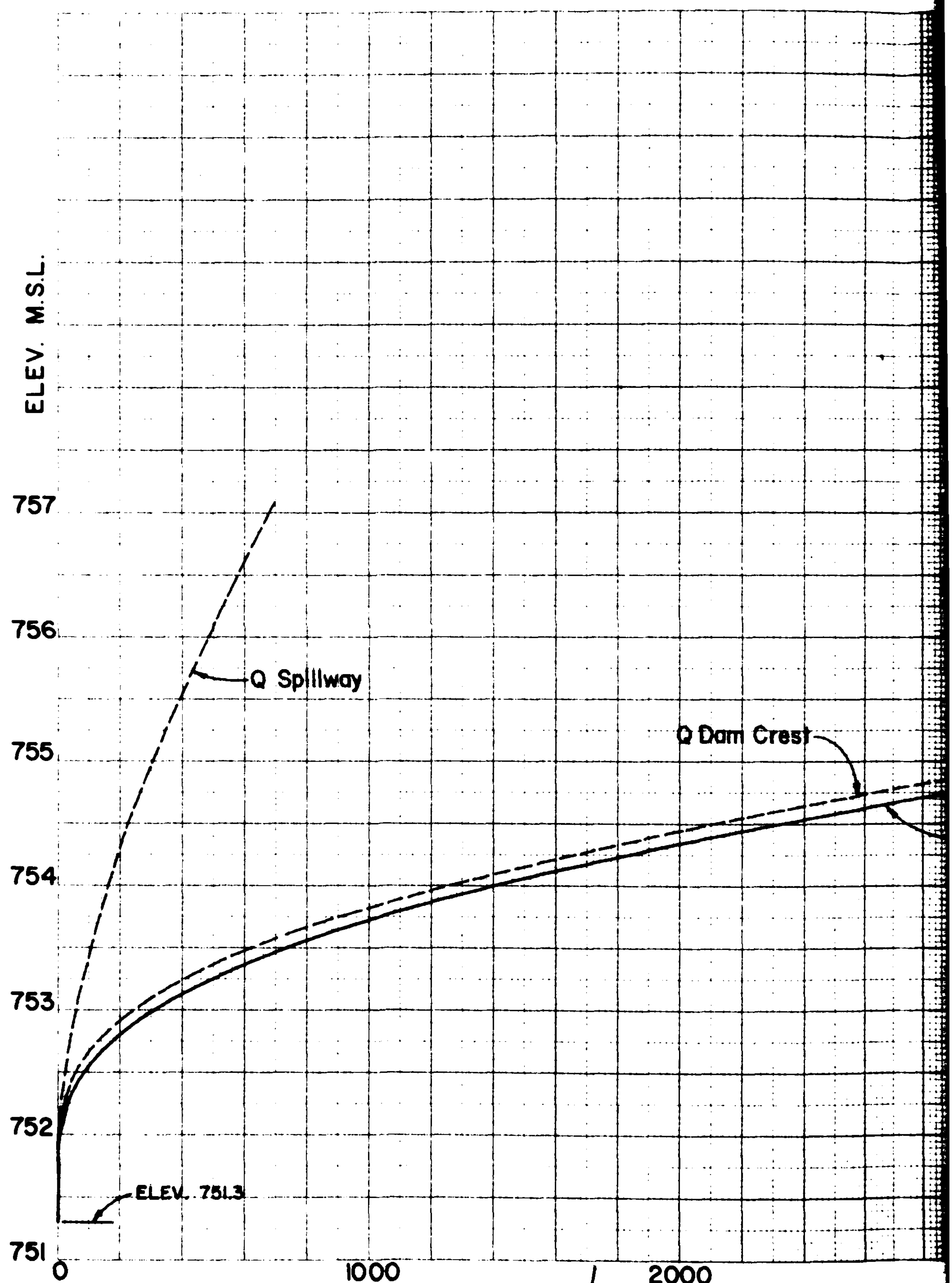
NOTE: DAM PROFILE LOOKING UPSTREAM.
DAM AXIS STRAIGHT.

PINE LAKE

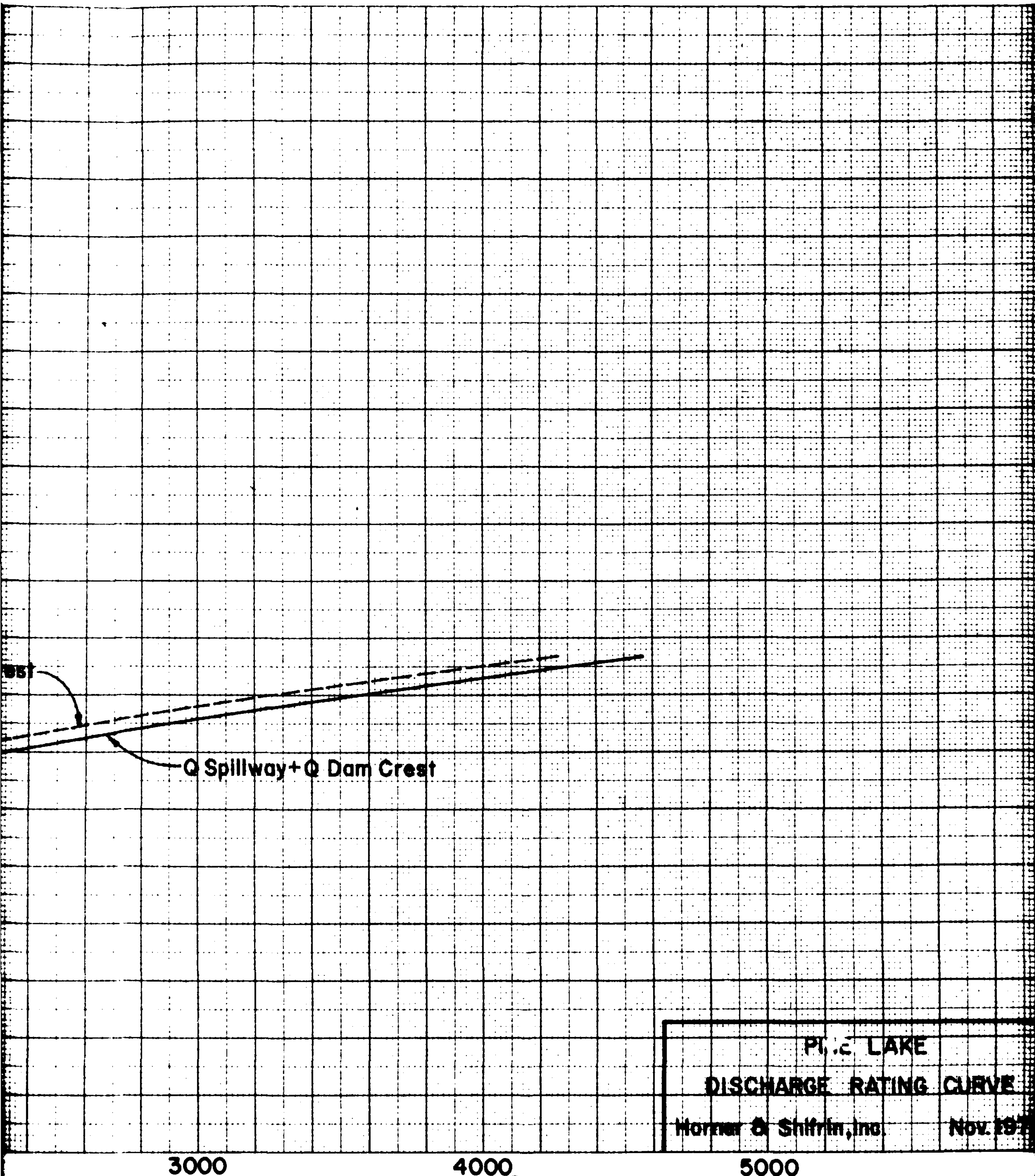
DAM & SPILLWAY PROFILES

Horner & Shifrin, Inc. Nov. 1978

2



ELEV. M.S.L.
757
756
755
754
753
752
751
Q Spillway
Q Dam Crest
ELEV. 751.3
0
1000
2000



Q Spillway+Q Dam Crest
3000
4000
5000
Q (cfs)
PI..c LAKE
DISCHARGE RATING CURVE
Horner & Shifrin, Inc.
Nov. 197

PLATE 4

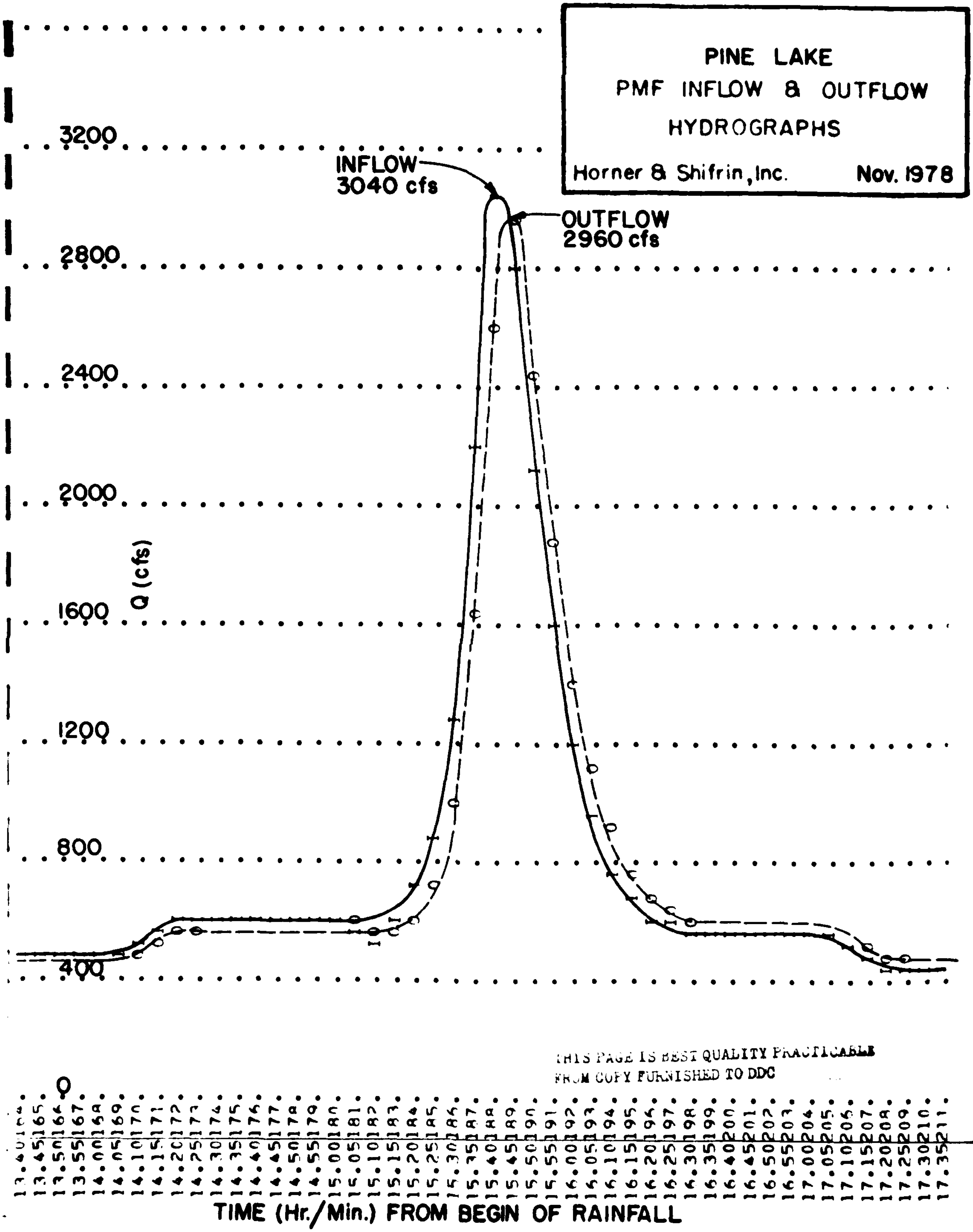

PINE LAKE
PMF INFLOW & OUTFLOW
HYDROGRAPHS
Horner & Shifrin, Inc.
Nov. 1978
INFLOW
3040 cfs
OUTFLOW
2960 cfs
3200
2800
2400
2000
1600
1200
800
400
0
Q (cfs)
TIME (Hr./Min.) FROM BEGIN OF RAINFALL

PLATE 5

APPENDIX


NO. 1: UPSTREAM FACE OF DAM


NO. 2: DOWNSTREAM FACE OF DAM

NO. 3: SPILLWAY CREST

NO. 4: SPILLWAY EXIT CHANNEL

NO. 5: POND BELOW DAM

HYDROLOGIC COMPUTATIONS

1. The HEC-1 Dam Safety Version (July 1978) program was used to develop inflow and outflow hydrographs and dam overtopping analyses, with hydrologic inputs as follows:

a. Probable maximum precipitation (200 sq. mile, 24-hour value equals 25.4 inches) from Hydrometeorological Report No. 33. One hundred year frequency (point precipitation, 24-hour value equals 7.23 inches) from U.S. Weather Bureau Technical Paper No. 40.

b. Drainage area = 0.24 square miles
= 154 acres

c. SCS parameters
Lag time = 0.15
Soil type CN = 91 (Soil type C, AMC III)

2. The spillway section consists of a broad-crested, approximately V-shaped excavated earth section for which conventional weir formulas do not apply.

Spillway release rates were determined as follows:

(1) Spillway crest section properties (area, a and top width, t) were computed for various depths, d.

(2) It was assumed that flow over the spillway crest would occur at critical depth. Flow at critical depth (Q_c) was computed as $Q_c = (\frac{a^3}{t} g)^{0.5}$ for the various depth, d.

Corresponding velocities (v_c) and velocity heads (H_{vc}) were determined using conventional formulas.

(3) Static lake levels corresponding to the various Q_c values passing over the spillway were computed as critical depths plus critical velocity head ($d_c + H_{vc}$), and the relationship between lake level and spillway discharge was thus obtained. The procedure neglects the minor insignificant friction losses across the length of the spillway.

3. The profile of the dam crest is irregular and flow over the dam crest cannot be determined by conventional weir formulas. Flow quantities overtopping the dam crest were computed as described in the preceding paragraph and corresponding flow over the dam and spillway for given elevations were added to obtain the combined outflow rating curve for the dam and spillway. This rating curve is shown on Plate 4. The inflow-outflow hydrographs for the PMF are shown on Plate 5.

```
*********************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  3 AUG 78
*********************************
    1               A1      ANALYSIS OF DAM OVERTOPPING USING RATIOS OF PMF
    2               A2      HYDROLOGIC-HYDRAULIC ANALYSIS OF SAFETY OF PINE LAKE DAM
    3               A3      RATIOS OF PMF ROUTED THROUGH RESERVOIR
    4               B      288       0       5      -0      -0      -0      -0      -0      -0      -0
    5               B1       5
    6               J        1       3       1
    7               J1    0.04    0.50    1.00
    8               K        0  INFLOW                                 3       1
    9               K1      INFLOW HYDROGRAPH
   10               M        1       2    0.24                     1.0                       1
   11               P        0    25.4     102     120     130
   12               T                                                     -1     -91
   13               W2            0.15
   14               X     -1.0    -.10     2.0
   15               K        1     DAM                     2       3       1
   16               K1      RESERVOIR ROUTING BY MODIFIED PULS
   17               Y                                1       1
   18               Y1       1                                            77      -1
   19               Y4   745.3   746.2   746.5     747   747.5     748   748.5     749   749.3
   20               Y5       0      29      85     315     745    1420    2360    3590    4560
   21               $A       0       6     7.6      11
   22               $E   706.8   745.3     750     760
   23               $$   745.3
   24               $D   745.9
   25               K       99
```

Equation: Increase elevations shown on Pages B-3 through B-6 by 6.0 feet; e.g., elevation 745.3 equals elevation 751.3.

```
*********************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  3 AUG 78
*********************************
 A1       ANALYSIS OF DAM OVERTOPPING USING 100 YR FLOOD
 A2       HYDROLOGIC-HYDRAULIC ANALYSIS OF SAFETY OF PINE LAKE DAM
 A3       100 YR FLOOD ROUTED THROUGH RESERVOIR
 B      288       0       5      -0      -0      -0      -0      -0      -0      -0
 B1       5
 J        1       1       1
 J1     1.0
 K         0  INFLOW                              3       1
 K1       INFLOW HYDROGRAPH
 M        0       2    0.24                     1.0                       1
 O      288
 O1    .007    .007    .007    .007    .007    .007    .007    .007    .007    .007
 O1    .007    .007    .007    .007    .007    .007    .007    .007    .007    .007
 O1    .007    .007    .007    .007    .007    .007    .007    .007    .007    .007
 O1    .007    .007    .007    .007    .007    .007    .007    .007    .007    .007
 O1    .007    .007    .007    .007    .007    .007    .007    .007    .007    .007
 O1    .007    .007    .007    .007    .007    .007    .007    .007    .007    .007
 O1    .007    .007    .007    .007    .007    .007    .007    .007    .007    .007
 O1    .007    .007    .014    .014    .014    .014    .014    .014    .014    .014
 O1    .014    .014    .014    .014    .014    .014    .014    .014    .014    .014
 O1    .014    .014    .014    .014    .014    .014    .014    .014    .014    .014
 O1    .014    .014    .014    .014    .014    .014    .014    .014    .022    .022
 O1    .022    .022    .022    .022    .022    .022    .022    .022    .022    .022
 O1    .022    .022    .022    .022    .022    .022    .031    .031    .031    .031
 O1    .031    .031    .061    .061    .061    .061    .061    .061    .132    .132
 O1    .132    .253    .253    .555    .830    .385    .253    .132    .132    .132
 O1    .061    .061    .061    .061    .061    .061    .031    .031    .031    .031
 O1    .031    .031    .022    .022    .022    .022    .022    .022    .022    .022
 O1    .022    .022    .022    .022    .022    .022    .022    .022    .022    .022
 O1    .014    .014    .014    .014    .014    .014    .014    .014    .014    .014
 O1    .014    .014    .014    .014    .014    .014    .014    .014    .014    .014
 O1    .014    .014    .014    .014    .014    .014    .014    .014    .014    .014
 O1    .014    .014    .014    .014    .014    .014    .007    .007    .007    .007
 O1    .007    .007    .007    .007    .007    .007    .007    .007    .007    .007
 O1    .007    .007    .007    .007    .007    .007    .007    .007    .007    .007
 O1    .007    .007    .007    .007    .007    .007    .007    .007    .007    .007
 O1    .007    .007    .007    .007    .007    .007    .007    .007    .007    .007
 O1    .007    .007    .007    .007    .007    .007    .007    .007    .007    .007
```

```
38   O1  .007    .007    .007    .007    .007    .007    .007    .007    .007    .007
39   O1  .007    .007    .007    .007    .007    .007    .007    .007    .007    .007
40   O1  .007    .007    .007    .007    .007    .007    .007    .007
41   T                                                     -1     -91
42   W2          0.15
43   X   -1.0    -.10     2.0
44   K      1     DAM                     2       3       1
45   K1      RESERVOIR ROUTING BY MODIFIED PULS
46   Y                               1       1
47   Y1     1                                            77      -1
48   Y4 745.3   746.2   746.5     747   747.5     748   748.5     749   749.3
49   Y5     0      29      85     315     745    1420    2360    3590    4560
50   $A     0       6     7.6      11

51   $E 706.8   745.3     750     760
52   $$ 745.3
53   $D 745.9
54   K     99
```

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	745.30	745.30	745.90
STORAGE	77.	77.	81.
OUTFLOW	0.	0.	19.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.04	746.26	.36	83.	40.	3.50	16.08	0.00
.50	748.00	2.10	94.	1413.	16.92	15.75	0.00
1.00	748.74	2.84	100.	2959.	17.58	15.75	0.00

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	745.30	745.30	745.90
STORAGE	77.	77.	81.
OUTFLOW	0.	0.	19.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.01	745.55	0.00	79.	8.	0.00	16.17	0.00
.02	745.79	0.00	80.	15.	0.00	16.17	0.00
.03	746.04	.14	82.	24.	2.25	16.17	0.00


FILM